1.2 Available Literature on In-Situ Oil Burning

A review of the existing literature was performed to identify potential data sources that could be used in lieu of field measurements. Emissions of open burning sources have attracted attention due to the potential for increased concentration of ambient air pollutants such as particulate matter[2] but also for their generation of persistent organic pollutants such as PAHs and PCDDs/Fs ("dioxins and furans"). [3-5] These persistent organic pollutants can undergo intercontinental transport[6] downwind from the source, deposit on the ground, on plants, or in bodies of surface water (inland, gulf, or coastal), and accumulate up through the food chain. As such, their main route of exposure is indirect through ingestion.[7] The EPA has an emissions inventory of dioxin releases that includes emission factors for multiple sources, but does not address oil spill burns.[8]

Available literature for emissions of air toxics from ocean burning of crude oil is very limited. Fingas et al published a series of papers that described a study by Environment Canada and EPA where measurements were made at sea of an oil spill burn.[9-12] Data were acquired for some pollutants (particulate, PAHs) in the smoke plume using remotely operated helicopters, but dioxins and furans were only measured at sea level outside the plume region, and observed downwind concentrations were statistically indistinguishable from upwind concentrations. Such sampling is not likely to provide a measurement of PCDD/F formation from the source since they are trace pollutants (i.e., it was not direct source sampling which is typically required for PCDDs/Fs). Since the study was targeted at localized exposures rather than overall impacts on a local, national, or global basis, only concentrations of pollutants were reported. A paper by Hunt[13] described some downwind measurements of criteria pollutants and volatile organic compounds (VOCs) from the Kuwaiti oil fires.

Although there are no direct measurements of PCDD/F from this source, there is some potential that PCDD/F will be formed at some level (although anticipated to be minimal) from this source. The question whether PCDDs/Fs are present at a level at which there is a human health or ecological concern. It is important to provide decision-makers with as much information as possible to make the most informed decisions. It is important to note, however, that operational decisions include information that includes, not only information on toxicity, but also implementation of options, institutional controls, technical feasibility, community acceptance, as well as other factors.

1.3 Background on Dioxins and Furans

Dioxins and dioxin-like compounds are hydrophobic, persistent compounds that bioaccumulate in fatty tissue. The term "dioxins" actually refers to two classes of compound: polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). There are a total of 210 dioxin compounds (75 PCDDs and 135 PCDFs), comprised of different homologues (groups of PCDDs or PCDFs with the same number of chlorine substitutions [1-8]) and isomers (compounds within a homologue having different substituted positions). Seven PCDDs and ten PCDFs, all having the 2, 3, 7, and 8 positions substituted with chlorines, are thought to contribute to toxicity. Dioxin-like compounds refer to compounds similar to dioxins, thought to also have some dioxin-like toxicity. These include compounds such as polybrominated dibenzo-p-dioxins/dibenzofurans (PBDDs/PBDFs) and polychlorinated biphenyls (PCBs).

PCDDs/Fs (and other compounds exhibiting dioxin-like toxicity, e.g., PCBs) are often found in complex mixtures in environmental media and biological samples, or from environmental releases. The concept of toxic equivalence has been developed to address this complicating factor. Toxic equivalency factors (TEFs) have been developed and used to facilitate risk assessment of exposure. TEFs compare the potential toxicity of each dioxin-like compound to the most toxic dioxin, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). 2,3,7,8-TCDD is assigned a TEF or 1.0, with the other 16 toxic congeners having a TEF developed as a weighted comparative toxicity (i.e., ranging from 0.00001 to 1.0).[4]

To determine the toxic equivalence (TEQ) of a mixture containing PCDDs/Fs, the TEF of each congener present in a mixture is multiplied by the respective mass concentration and the products are summed. International accepted TEF values have been established and are routinely used for the determination of TEQs. Hence, PCDD/F concentrations (in emission sources or biological samples) are typically expressed on a mass-volume (ng TEQ per m^3) or mass-mass (ng TEQ per kg fuel or kg sample) basis. A reassessment of describing dioxin-like toxicity is currently on-going.[7]

TEQs are typically reported for convenience in presenting summary information and to facilitate comparison across sources. However, for environmental fate modeling it is important to use the individual CDD/CDF values due to the varying physical/chemical properties of each congener (i.e., each congener will behave differently in the environment). The PCDDs and PCDFs profiles released from a source cannot be assumed to remain constant during transport through the atmosphere and deposition to various media.

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